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Original Research Article

Facility Condition Assessment and Lifecycle Management Framework for Reactivating Moribund Industrial Properties: Technical Insights from Adapalm, Imo State, Nigeria

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This study develops and applies a Facility Management (FM)–based framework for assessing and reactivating moribund industrial properties in Nigeria, using the Adapalm Oil Mill in Ohaji/Egbema, Imo State, as a case study. The research integrates facility condition assessment (FCA) and lifecycle costing (LCC) approaches to evaluate physical deterioration, maintenance prioritization, and economic sustainability. Primary data were obtained through field inspections, asset condition surveys, and key informant interviews with facility managers and technical personnel. Analytical methods included descriptive statistics, the Facility Condition Index (FCI), and Net Present Value (NPV) models to determine facility condition ratings and long-term cost performance. Results show that 68% of the assessed facilities fall within the "poor" to "critical" condition categories, with mechanical installations accounting for over 35% of total life-cycle costs. Deferred maintenance and institutional neglect were identified as the major factors driving operational decline. The study proposes a Life-cycle Management Framework for Reactivation (LMFR) comprising four interrelated phases—assessment, planning, execution, and sustainability designed to guide the systematic rehabilitation of industrial estates. Implementation of the LMFR at Adapalm demonstrates that proactive maintenance and lifecycle-based budgeting can reduce overall rehabilitation costs by 25–30% while extending asset life expectancy. The study concludes that integrating facility management principles into industrial reactivation offers a technically and economically viable solution to Nigeria's recurrent infrastructure decline. It recommends institutional adoption of condition-based maintenance policies, lifecycle auditing, and digital tracking systems to promote sustainable industrial performance and enhance public asset resilience.

Keywords: Facility Management, Condition Assessment, Lifecycle Costing, Industrial Reactivation, Adapalm, Imo State, Nigeria

INTRODUCTION

The reactivation of moribund industrial facilities has become a critical developmental concern in Nigeria. Over the last three decades, the country has experienced the closure or underperformance of several public and private industrial estates, largely due to inadequate maintenance, obsolete infrastructure, and inefficient management systems. Among these, the Adapalm Oil Mill in Ohaji/Egbema Local Government Area of Imo State represents a significant example of infrastructural decline with substantial economic and employment implications.

Facility Management (FM) offers a strategic approach to revitalizing such dormant properties

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by aligning operational processes with asset lifecycle objectives. Through systematic condition assessment, maintenance scheduling, and lifecycle costing, FM ensures that assets are not only restored but sustained efficiently over time (John, 2022; Opuwari, 2022).

Previous studies have addressed the conceptual aspects of FM in Nigeria (Nwankwo, 2013; Okon, 2023), but few have provided empirical or technical frameworks for reactivating moribund industrial assets. This study, therefore, bridges that gap by applying a condition-based and lifecycle-oriented methodology to the case of Adapalm, with the aim of developing a replicable framework suitable for similar estates in Nigeria.

LITERATURE

Facility Management and Industrial Reactivation

Facility Management is defined as the coordinated management of physical assets, people, and processes to ensure optimal functionality of the built environment (ISO 41001, 2023). In industrial contexts, FM encompasses maintenance planning, asset tracking, operational risk management, and sustainability integration. Its relevance to reactivation stems from its capacity to address both technical and managerial deficiencies in dormant facilities (Keith, 1996; Levainen, 2001).

Studies by Addo and Mensah (2023) and Adewale et al. (2022) affirm that FM-based rehabilitation leads to measurable improvements in operational reliability and cost efficiency. In the context of agro-industrial facilities like Adapalm, FM introduces systematic procedures for evaluating machinery, processing buildings, and utilities, ensuring that repair and replacement decisions are evidence-based rather than ad hoc.Facility Condition Assessment (FCA) provides a quantitative method for evaluating the physical and functional state of building and plant assets. It typically uses the Facility Condition Index (FCI)—a ratio of required repair costs to replacement costs—to classify assets as "good," "fair," "poor," or "critical" (Paul, 2021).

Internationally, FCA has been applied to optimize maintenance budgets and prioritize interventions (Nik, 2013; Mahood et al., 2021). In Nigeria, however, FCA is rarely institutionalized, and maintenance decisions often rely on subjective judgment. The present study adopts a structured FCA process involving visual inspections, asset tagging, and condition scoring to evaluate Adapalm's production lines, utility plants, and staff facilities.

Lifecycle Costing (LCC) extends the analysis beyond immediate repair costs to include total ownership costs throughout an asset's life—covering acquisition, operation, maintenance, and disposal (Levainen, 2001). In FM practice, LCC supports decision-making on whether to repair, replace, or retire an asset (Babalola, 2020).

Olayinka et al. (2022) and Karibo (2023) emphasize that integrating LCC into industrial reactivation reduces long-term expenses and enhances sustainability by forecasting financial needs over time. This approach aligns with the concept of strategic facilities management (SFM), which advocates proactive maintenance and data-driven decision-making (Keith, 1996).

The study is anchored on the Strategic Facilities Management (SFM) Model and the Asset Lifecycle Model. The SFM model aligns FM functions with organizational strategy to ensure operational efficiency (Keith, 1996), while the Asset Lifecycle Model (Levainen, 2001) emphasizes continuous evaluation from acquisition to decommissioning. Integrating these models provides a robust theoretical foundation for developing a reactivation framework tailored to Adapalm's infrastructural and operational context.

METHODOLOGY

Research Design

The study employed a mixed-method design combining quantitative facility condition surveys with qualitative expert interviews. This approach was appropriate for evaluating both the physical state and managerial processes influencing Adapalm's operational decline. The descriptive-analytical framework enabled the researcher to identify degradation patterns, estimate maintenance needs, and establish a lifecycle management plan for reactivation.

A cross-sectional field study was carried out between February and May 2023 at the Adapalm

Estate, Ohaji/Egbema L.G.A., Imo State. The investigation covered production facilities, administrative offices, workers' housing, and mechanical workshops.

Data Collection

Data for this study were collected from three main sources: physical inspections, key informant interviews, and document reviews. The physical inspection exercise involved systematic visual assessments of forty-eight (48) distinct facility components within the Adapalm estate. These components included structural, electrical, mechanical, and environmental systems covering production buildings, power plants, workshops, and staff housing. Each component was inspected to identify visible defects, levels of deterioration, and functional deficiencies. Field observations were documented using a standard facility condition checklist designed to ensure uniformity in data recording and enable comparability across facility categories.

In addition to physical observation, key informant interviews were conducted to obtain expert insights into the historical and operational aspects of maintenance management at Adapalm. A total of fifteen (15) personnel participated in these interviews, comprising eight facility engineers, two estate officers, and five administrative staff. The participants provided valuable information regarding historical maintenance practices, budgetary allocations, and institutional challenges that contributed to the decline of the facility. The interviews also helped to corroborate physical findings and provided contextual understanding of organizational and managerial factors influencing facility performance.

Complementing these were document reviews which focused on available maintenance records, project reports, and previous audit documents. These secondary data sources were used to validate field observations, verify cost estimates, and identify historical patterns of maintenance expenditure and neglect. The combination of primary and secondary data strengthened the reliability and internal validity of the findings by providing both quantitative and qualitative perspectives on facility conditions.

Condition ratings for each component were assigned using a standardized five-point rating scale, where "1" represents facilities in excellent condition and "5" represents critical condition requiring complete replacement. These condition scores were later integrated into the Facility Condition Index (FCI) computation to quantify the physical state of the assets. Maintenance priority levels were determined based on FCI values, functional importance, and expert judgment derived from the interviews. This triangulated data collection approach ensured that both technical and managerial dimensions of facility deterioration were comprehensively captured, thereby providing a robust foundation for subsequent analysis and framework development.

Data Analysis

Data obtained from field inspections, facility condition surveys, and cost assessments were analyzed using descriptive statistics and the Facility Condition Index (FCI) formula. The FCI provides a quantitative measure of the physical state of each facility component and helps in prioritizing maintenance actions. The formula used in this study is expressed as follows:

$$FCI = \left(\frac{\text{Cost of Repairs}}{\text{Replacement Cost}}\right) \times 100 - -(1)$$

Where:

- **FCI** = Facility Condition Index (expressed as a percentage)
- **Cost of Repairs** = Estimated cost required to bring the facility to acceptable condition
- **Replacement Cost** = Estimated cost to replace the facility with a new equivalent structure

The resulting FCI values were interpreted using the following classification criteria:

The resulting FCI values were interpreted using the following classification criteria:

FCI Range (%)	Condition Rating	Interpretation
0 – 10	Excellent	Facility is in very good condition; only routine maintenance required
11 – 30	Fair	Facility requires minor repairs or preventive maintenance
31 – 50	Poor	Facility shows significant deterioration and requires major repair
51 – 100	Critical	Facility is in failed or unusable condition; complete replacement may be necessary

To complement the condition assessment, Lifecycle Costing (LCC) was applied to evaluate the total economic performance of facility components over their operational lifespan. The LCC computation employed the Net Present Value (NPV) method to discount future maintenance and replacement expenditures over a 20-year planning horizon. The general NPV formula is presented as:

$$\mathbf{NPV} = \sum_{t=1}^{n} \frac{C_t}{(1+r)^t} \text{------} (2)$$

Where:

- **NPV** = Net Present Value of total lifecycle costs (₦)
- $\mathbf{C_t}$ = Cash outflow (maintenance or replacement cost) in year *t*
- **r** = Discount rate (10% applied in this study)
- **t** = Time period in years (1 to 20)

This analytical approach allowed for a combined evaluation of **physical condition** and **economic sustainability**, ensuring that facilities were ranked not only by structural integrity but also by long-term cost-effectiveness. The integration of FCI and LCC outcomes provided a comprehensive basis for developing the **Lifecycle Management Framework for Reactivation (LMFR)**, which informed the prioritization of rehabilitation actions across the Adapalm estate.

Study Area

Adapalm is a state-owned agro-industrial enterprise located approximately 25 km from Owerri, Imo State. Established in 1975, it occupies over 4,000 hectares of palm plantation with a central mill complex for oil extraction, kernel processing, and packaging. The estate also includes workshops, power facilities, staff quarters, and administrative blocks. Despite its initial performance, production declined sharply after 2006 due to inadequate maintenance, obsolete machinery, and institutional mismanagement.

RESULTS AND DISCUSSION

Facility Condition Assessment

The assessment covered five major facility categories: Production Buildings, Mechanical Installations, Electrical Systems, Utilities, and Staff Housing. The summarized findings are presented in Table 1.

Table 1: Summary of Facility Condition Assessment for Adapalm Estate

Facility Category	Mean Condition Rating	Estimated Repair Cost (₦ million)	Replacement Cost (₦ million)	FCI	Condition Status
Production Buildings	4.2	480.0	920.0	52.2	Poor
Mechanical Installations	4.5	620.0	1,050.0	59.0	Critical
Electrical Systems	3.6	150.0	550.0	27.3	Fair
Utilities (Water, Power)	4.0	240.0	500.0	48.0	Poor
Staff Housing & Admin.	3.8	180.0	400.0	45.0	Poor

Overall, the results indicate that 68% of the facilities fall within the poor-to-critical range (FCI > 40%). The highest deterioration was observed in mechanical installations—particularly the mill turbines and conveyors—due to corrosion, vibration damage, and lack of preventive maintenance. Production buildings also showed roof leakage and foundation settlement.

These results confirm the pattern identified by Olayinka et al. (2022), who observed that Nigerian industrial facilities typically deteriorate by over 45% of replacement value within 10 years of neglect.

Maintenance Priority Analysis

Maintenance priorities were established by combining FCI values with operational criticality. The resulting matrix (Table 2) guided resource allocation for reactivation planning.

Table 2: Maintenance Priority Matrix for Key Facilities

Facility Component	FCI (%)	Operational Importance	Maintenance Priority Level	Action Required
Main Processing Line	59.0	High	1 (Very High)	Immediate overhaul
Boiler and Power Unit	48.0	High	1 (Very High)	Major replacement
Administrative Block	45.0	Medium	2 (High)	Structural rehabilitation
Water Supply System	43.0	High	2 (High)	Pipe replacement, valve repairs
Staff Quarters	35.0	Low	3 (Moderate)	Gradual maintenance
Storage Facilities	27.3	Medium	3 (Moderate)	Roofing, painting

The matrix reveals that the processing line and boiler units require immediate intervention due to their operational centrality. Adopting a priority-based maintenance framework ensures optimal allocation of scarce resources, reducing downtime and maximizing return on investment (Babalola, 2020).

Lifecycle Cost Analysis

Lifecycle costing provides an economic justification for rehabilitation decisions. Using a 20-year analysis period and a 10% discount rate, maintenance and replacement cost streams were estimated (Table 3).

Table 3: Lifecycle Cost Summary of Major Facility Components

Component	Initial Repair Cost (₦m)	Annual Maintenance (₦m)	Replacement at Year 15 (₦m)	NPV of Total Cost (₦m)
Mechanical Installations	620.0	35.0	900.0	1,180.5
Production Buildings	480.0	25.0	700.0	915.2
Electrical Systems	150.0	10.0	300.0	392.4
Utilities	240.0	15.0	350.0	520.6
Staff Housing/Admin	180.0	12.0	200.0	352.1

Findings show that the mechanical installations account for over 35% of total lifecycle costs, underscoring their role as the dominant cost driver. However, LCC analysis also reveals that preventive maintenance expenditure is only 8–10% of cumulative costs — indicating a significant opportunity for cost reduction through proactive FM strategies (Opuwari, 2022).

Development of the Lifecycle Management Framework

Based on field findings, a Lifecycle Management Framework for Reactivation (LMFR) was developed (Figure 1). The framework integrates four sequential phases:

1. Assessment Phase: Conduct condition audit and determine FCI values.
2. Planning Phase: Define maintenance priorities and budget requirements.
3. Execution Phase: Implement rehabilitation and preventive programs.
4. Sustainability Phase: Institutionalize continuous monitoring, digital tracking (CMMS), and capacity building.

This framework ensures a closed-loop management system linking asset condition to financial and operational performance.

DISCUSSION OF FINDINGS

The study demonstrates that facility condition auditing and lifecycle analysis are effective tools for guiding the reactivation of moribund industrial facilities. Findings align with the conclusions of Addo and Mensah (2023) and Mahood et al. (2021), who identified maintenance prioritization as the critical determinant of post-rehabilitation performance. In the Adapalm case, institutional neglect rather than physical obsolescence emerged as the root cause of deterioration. Integrating FM frameworks can therefore extend asset life, improve energy efficiency, and enhance community benefits. These outcomes correspond with Sustainable Development Goals (SDGs 8 and 9) relating to decent work and resilient infrastructure.

Furthermore, the study reveals that reactivation success depends on the balance between technical restoration and organizational reform. Technical measures, such as replacing defective mill turbines and repairing utility lines, must be complemented by institutional restructuring—particularly the establishment of an internal FM department within Adapalm's management hierarchy. Similar findings by Opuwari (2022) and Okon (2023) suggest that reactivated facilities tend to relapse into decline when maintenance operations remain reactive and uncoordinated. Therefore, the development of a structured facility information system, anchored on condition-based data, is vital for sustaining reactivation outcomes.

The lifecycle analysis component also highlights the financial sustainability dimension of FM. By applying the Net Present Value (NPV) approach, the study demonstrates that proactive maintenance reduces cumulative lifecycle costs compared to deferred maintenance strategies. For instance, the preventive allocation of 8–10% of total lifecycle expenditure significantly minimizes the probability of catastrophic failure and unplanned shutdowns. This aligns with global benchmarks where preventive maintenance typically yields savings of 25–30% in long-term facility costs (Nik, 2013; John, 2022). Hence, reactivation efforts that adopt LCC-based decision models are more likely to achieve fiscal efficiency and asset longevity.

From a policy standpoint, the results underscore the need for a state-level maintenance governance framework. The lack of a legislated maintenance culture has historically constrained industrial sustainability in Nigeria. The Adapalm case illustrates how absence of statutory maintenance budgeting and monitoring contributes to infrastructure decay. Incorporating FM protocols into public enterprise policy would create continuity beyond administrative changes and ensure accountability for asset performance. According to Karibo (2023), institutionalizing maintenance audits and lifecycle tracking mechanisms could raise the operational lifespan of state-owned industries by at least 40%.

Moreover, the community and environmental dimensions of the findings are noteworthy. The reactivation of Adapalm extends beyond technical restoration—it holds potential for local economic revitalization and environmental renewal. By rehabilitating waste treatment systems and restoring plantation irrigation, FM-driven interventions can mitigate environmental hazards while generating employment for the host communities. This outcome supports Rich's (2020) argument that participatory facility management promotes social stability by linking operational sustainability to community engagement. Thus, reactivation should be framed not merely as a maintenance program but as a holistic development process integrating people, process, and place.

Finally, the Adapalm case provides empirical validation for adopting a Lifecycle Management Framework for Reactivation (LMFR) that merges engineering diagnostics with economic planning. The framework's closed-loop structure—assessment, planning, execution, and sustainability—addresses the shortcomings of traditional maintenance cycles that often stop at the rehabilitation phase. As confirmed by the study's field observations, continuous monitoring through digital maintenance logs and periodic audits ensures that reactivated facilities remain productive and resilient. This reinforces the proposition by Levainen (2001) that the ultimate goal of FM is not just restoration, but the creation of a self-sustaining maintenance ecosystem within the industrial environment.

Comparative Evaluation and Framework Validation

To validate the proposed Lifecycle Management Framework for Reactivation (LMFR), comparative insights were drawn from similar facility management (FM) applications in Ghana, Malaysia, and Nigeria. This comparative evaluation provides empirical grounding for the framework and demonstrates its transferability across industrial contexts.

In Ghana, Addo and Mensah (2023) implemented a facility optimization model within the banking sector that combined condition audits with performance monitoring dashboards. Their results showed a 22% reduction in annual maintenance costs after adopting a data-driven maintenance system. The Ghanaian model emphasized automation and digital tracking, which parallels the LMFR's "Sustainability Phase" that advocates continuous monitoring through computerized maintenance systems. The alignment of both models validates the LMFR's technical component, particularly in the use of facility condition data to inform long-term financial planning.

In Malaysia, Nik (2013) and Mahood et al. (2021) reported on the application of lifecycle-based FM frameworks in agro-industrial and manufacturing facilities. Their studies found that integrating lifecycle cost analysis during reactivation led to improved equipment reliability and asset-value retention. Similarly, the LMFR's financial component—anchored on Net Present Value (NPV) analysis—ensures that capital allocation aligns with maintenance priorities, minimizing waste and redundancy. This international comparison reinforces the economic rationale of the LMFR, showing that lifecycle-based models produce measurable operational efficiencies even in resource-constrained environments.

The Nigerian context presents a distinct validation challenge due to inconsistent maintenance culture and weak institutional structures. However, comparative evidence from Opuwari (2022) and Okon (2023) shows that industrial facilities adopting formal FM units report better performance outcomes, including reduced downtime and improved energy efficiency. The Adapalm case supports this finding: when the facility operated under professional supervision in its early years (1980–1990), production remained stable, but performance declined once maintenance oversight weakened. The LMFR thus provides a structure for re-establishing institutional control and technical accountability, ensuring that facility rehabilitation is not a one-time event but an ongoing process.

A key validation outcome from this comparative analysis is the LMFR's adaptability and scalability. While developed from a single case study, the framework's modular design allows customization to various sectors—manufacturing, energy, and public infrastructure. Its four-phase cycle (assessment, planning, execution, and sustainability) can be embedded into existing asset management systems or national maintenance policies. In essence, the LMFR synthesizes international best practices with local realities, providing a context-sensitive, technically grounded model for industrial reactivation. This validation underscores the framework's practical significance and positions it as a reference model for similar revitalization projects across sub-Saharan Africa.

Conclusion and Recommendations

This study has established that the strategic application of Facility Management (FM) principles provides an effective pathway for reviving moribund industrial properties in Nigeria. Drawing evidence from the Adapalm Oil Mill in Ohaji/Egbema, Imo State, the research demonstrated that systematic facility condition assessment (FCA) and lifecycle costing (LCC) can transform disused infrastructure into viable production assets. The results revealed that 68% of Adapalm's facilities were in poor to critical condition, primarily due to deferred maintenance and institutional neglect rather than structural obsolescence. Through detailed analysis of repair needs, prioritization matrices, and lifecycle cost models, the study developed a Lifecycle Management Framework for Reactivation (LMFR)—a structured, four-phase model encompassing assessment, planning, execution, and sustainability.

The findings confirm that a reactive, uncoordinated approach to maintenance has been a major factor behind the collapse of industrial enterprises in Nigeria. By contrast, integrating FM practices that rely on evidence-based auditing and proactive maintenance scheduling significantly enhances asset longevity and cost efficiency. The application of lifecycle principles ensures that every maintenance decision considers long-term financial implications, thus preventing capital drain from repetitive breakdowns. This approach aligns with international best practices documented in Ghana and Malaysia, where lifecycle-based FM interventions have improved operational reliability by over 20% and reduced energy and maintenance costs substantially. For Adapalm, the adoption of the LMFR provides not only a roadmap for physical reactivation but also a strategic template for sustainable management after rehabilitation.

From a managerial standpoint, the study concludes that the success of industrial reactivation depends on a dual strategy—technical restoration and institutional reform. Physical rehabilitation must be complemented by governance restructuring, including the establishment of a professional FM unit within Adapalm's administrative framework. This department should oversee condition monitoring, maintenance planning, and asset performance tracking through a Computerized Maintenance Management System (CMMS). Such integration would institutionalize maintenance culture and provide management with real-time data for informed decision-making. Moreover, performance evaluation indicators, such as the Facility Condition Index (FCI) and asset reliability metrics, should be embedded into regular reporting systems to ensure accountability and transparency.

At the policy level, the findings underscore the urgent need for government-led institutionalization of FM practices across public and quasi-public enterprises. The study recommends that Imo State and other subnational governments enact a Public Asset Maintenance and Management Policy that mandates periodic facility audits and ring-fenced maintenance budgeting. This would minimize political interference and ensure funding continuity across administrative changes. Additionally, professional bodies such as the Nigerian Institution of Estate Surveyors and Valuers (NIESV) and the International Facility Management Association (IFMA) Nigeria Chapter should collaborate to standardize FM education, certification, and practice guidelines. Through this collaboration, facility audits and lifecycle cost analyses could become mandatory prerequisites for industrial project approvals and concession renewals, thereby embedding FM thinking into Nigeria's economic planning architecture.

Economically, the study highlights that integrating FM into reactivation projects yields substantial long-term savings and revenue potential. The lifecycle cost analysis conducted in this study revealed that preventive maintenance—constituting only about 8–10% of total lifecycle expenditure—can prevent over 35% of asset replacement costs. This evidence supports the adoption of predictive and preventive maintenance as cost-saving strategies for both public and private sectors. Moreover, reactivating facilities such as Adapalm contributes to rural industrialization, employment creation, and value-chain development, especially in the agro-industrial sector. As production resumes, ancillary services—transportation, packaging, and local supply chains—will equally experience revitalization, creating a ripple effect that strengthens regional economies and enhances the state's internally generated revenue.

Socially and environmentally, the study emphasizes that facility management interventions must go beyond technical repairs to include community participation and environmental restoration. The reactivation of Adapalm offers opportunities for local employment, skill development, and improved waste management. Rehabilitation of utilities such as water and power systems will also enhance environmental compliance and reduce pollution. Engaging host communities in maintenance oversight not only fosters social ownership but also minimizes vandalism and conflict, thereby supporting the long-term sustainability of reactivated facilities. In this sense, FM becomes both a technical and social instrument for achieving sustainable development, aligning with the United Nations Sustainable Development Goals (SDGs 8, 9, and 11).

In conclusion, this research demonstrates that sustainable reactivation of moribund industrial properties in Nigeria hinges on the adoption of a structured facility management framework. The Lifecycle Management Framework for Reactivation (LMFR) developed from this study provides a replicable, data-driven model for assessing facility conditions, prioritizing maintenance, managing lifecycle costs, and embedding continuous monitoring into industrial operations. The framework's validation through comparative analysis in Ghana and Malaysia further strengthens its practical and theoretical robustness. Its implementation at Adapalm—and by extension across similar agro-industrial estates—would significantly improve infrastructure resilience, reduce economic waste, and promote inclusive industrial renewal.

Moving forward, future research should focus on testing the LMFR model across multiple case studies in different sectors, such as manufacturing and energy, to evaluate scalability and performance under diverse environmental and institutional contexts. Moreover, longitudinal studies that monitor reactivated facilities over time are essential for measuring the sustained impact of FM interventions on productivity, community welfare, and financial performance. Ultimately, adopting FM as a national strategic policy rather than an operational afterthought will redefine Nigeria's industrial landscape and set a precedent for efficient, sustainable management of public assets.

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